

Supplement to

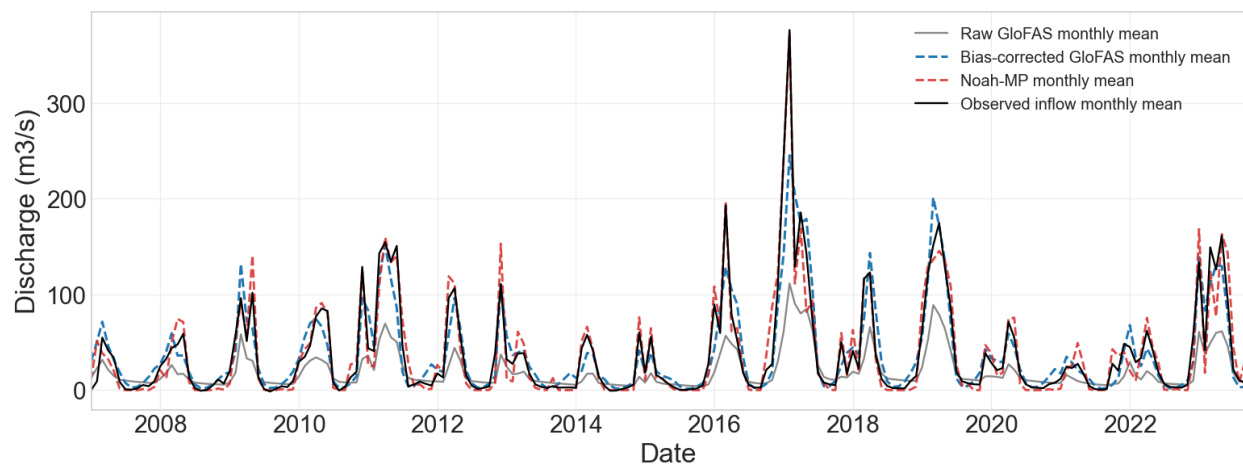
SWOT-initialized reservoir operation forecasting: Validation in data-rich and application to data-limited regions

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Section S1. Evaluation of Historical Inflow Simulations and GloFAS Bias Correction

Figures S1 and S2 compare historical monthly inflow simulations from the bias-corrected GloFAS product (using the procedure described in Section 4.2 of the main text) and the Noah-MP-based modeling framework with in situ observations at New Bullards Bar Reservoir (BUL) and Don Pedro Reservoir (DNP), respectively.. Both simulations capture the broad seasonal and interannual variability in monthly inflows, although their performance varies by reservoir and model. At BUL (Figure S1), the bias-corrected GloFAS and Noah-MP-based historical inflow simulations achieved (monthly) KGE values of 0.85 and 0.95, respectively, with corresponding RMSE values of 21.0 and 14.3 m³ s⁻¹. At DNP (Figure S2), the corresponding KGE values were 0.82 and 0.85, respectively, with corresponding RMSE values of 35.3 and 40.7 m³ s⁻¹. Comparison of the raw and bias-corrected GloFAS simulations in Figures S1 and S2 shows that bias correction improved the representation of seasonal peak inflows. Nevertheless, both the bias-corrected GloFAS and Noah-MP-based historical inflow simulations showed larger errors during high-flow months, as indicated by the greater scatter at higher observed inflows in Figures S1 and S2.



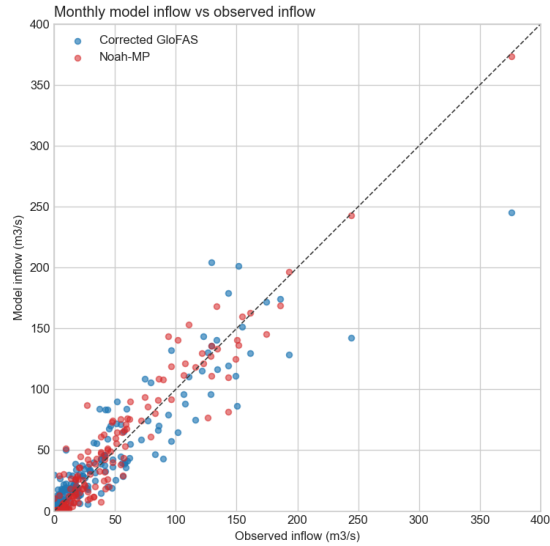
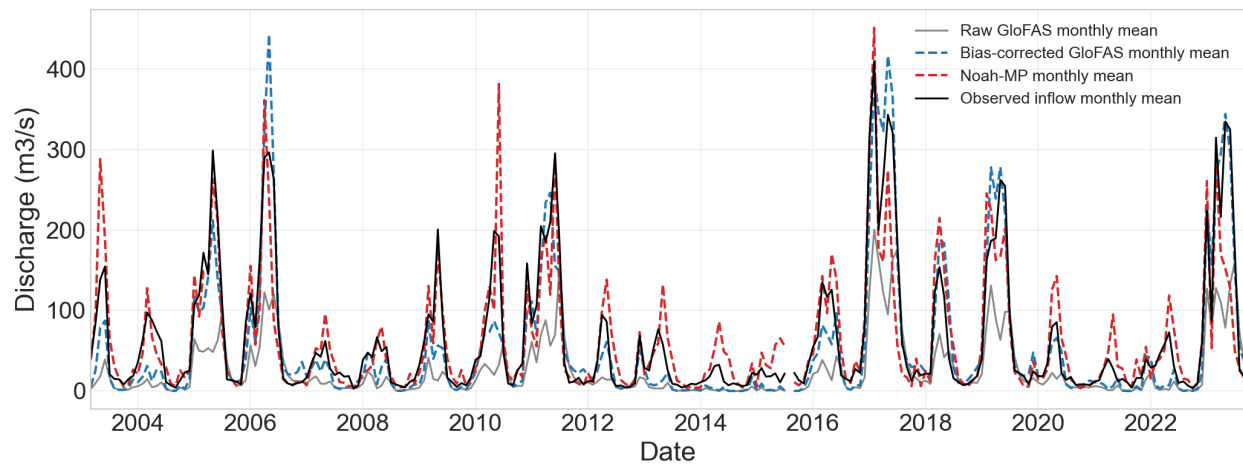


Figure S1. Evaluation of bias-corrected GloFAS and Noah-MP-based historical monthly inflow simulations relative to in situ observations for New Bullards Bar Reservoir (BUL), California. The time series compares observed monthly mean inflow with raw GloFAS, bias-corrected GloFAS, and Noah-MP simulations during 2007–2023. The scatterplot compares monthly inflow simulated by bias-corrected GloFAS and Noah-MP against in situ observations. The dashed diagonal line represents the 1:1 relationship.



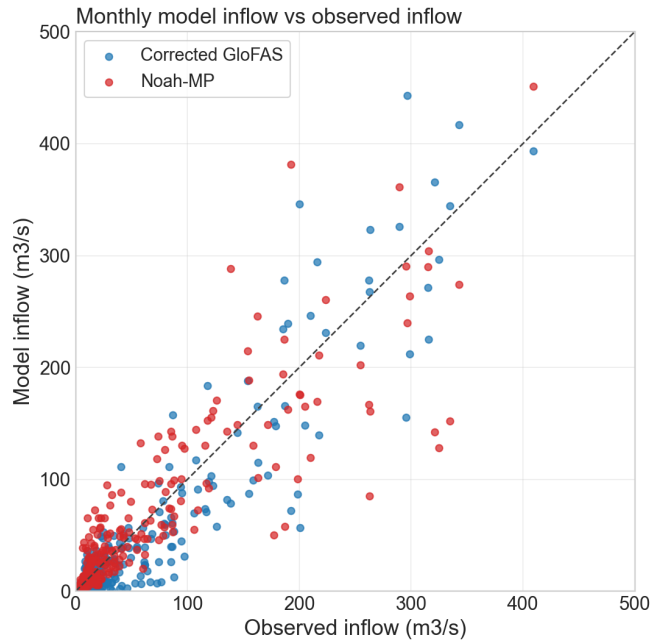


Figure S2. Evaluation of bias-corrected GloFAS and Noah-MP-based historical monthly inflow simulations relative to in situ observations for Don Pedro Reservoir (DNP).

Section S2. Evaluation of Inflow Forecasts Initialized during the Low-Flow Period

Figures S3 and S4 compare monthly Noah-MP-based Ensemble Streamflow Prediction (ESP) and GloFAS inflow forecasts initialized from May through August in 2024 and 2025, with forecast leads extending from each initialization date through the end of the corresponding water year, at New Bullards Bar Reservoir (BUL) and Don Pedro Reservoir (DNP), respectively. As shown in Figures S3 and S4, both forecast methods capture the seasonal decline in reservoir inflow from late spring toward the summer low-flow period. Forecasts initialized in May show the largest inflow magnitudes and the widest ESP ensemble spread, particularly at BUL, whereas forecasts initialized in July and August remain consistently low throughout the forecast period. BUL generally exhibits larger inflow magnitudes and greater forecast uncertainty than DNP, while inflows at DNP are lower and the forecast means remain relatively close to the observations during most low-flow months. At both reservoirs, ESP and GloFAS reproduce the broad transition toward low-flow conditions, although differences are evident during the early forecast months and around individual inflow peaks. The ESP ensemble spread generally increases with lead time, especially near the end of the forecast horizon. Overall, the results indicate that both ESP and GloFAS reasonably capture the seasonal evolution of low-flow inflows, while

uncertainty is greater for earlier initialization dates, longer lead times, and the higher-flow conditions at BUL.

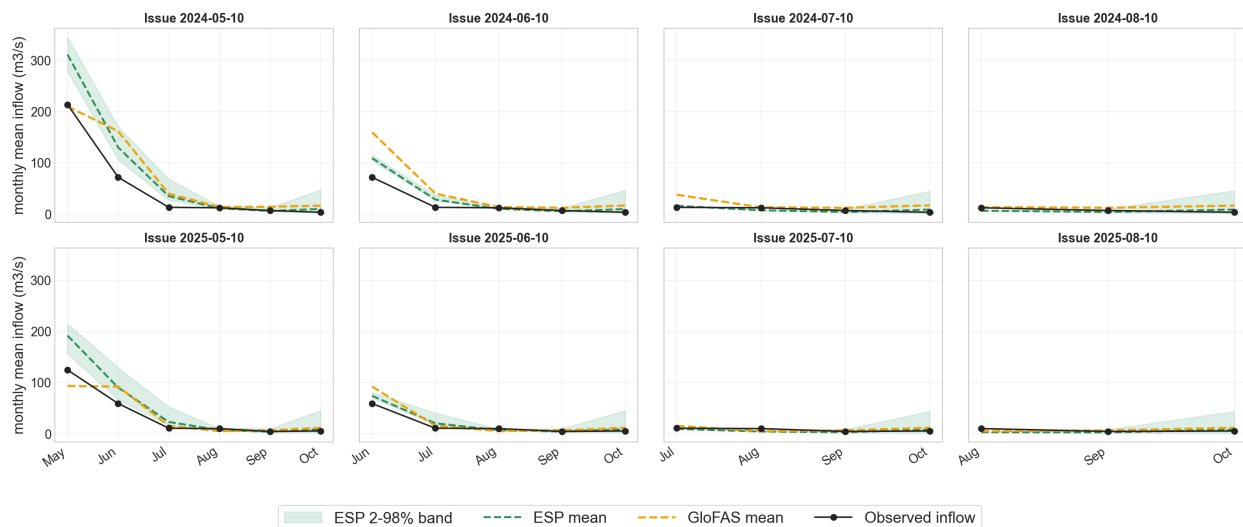


Figure S3. Comparison of ESP and GloFAS monthly inflow forecasts initialized during the May–August low-flow period at New Bullards Bar Reservoir (BUL) for 2024 and 2025.

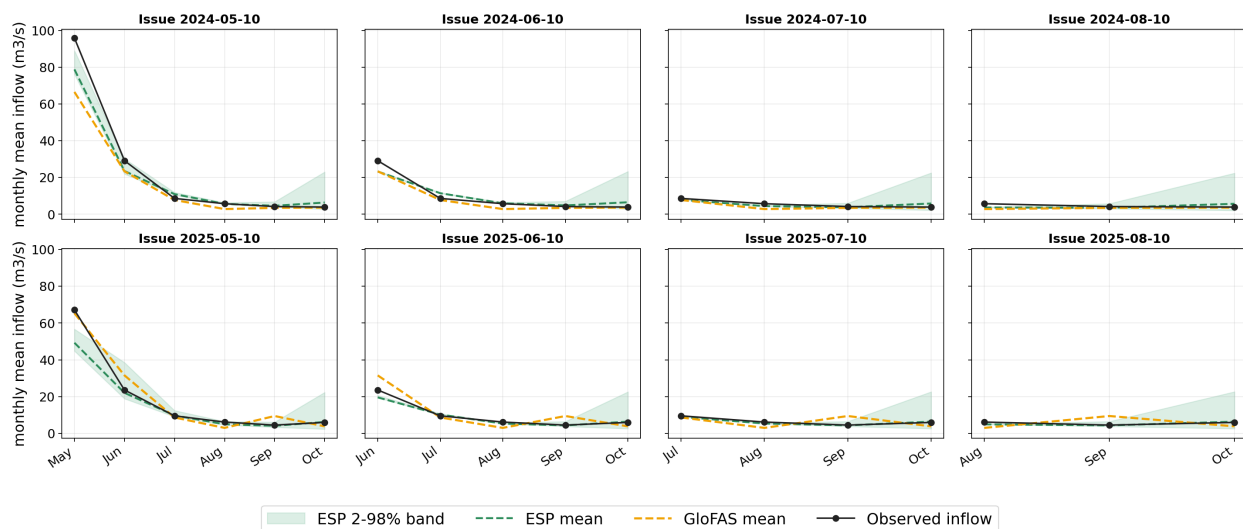


Figure S4. Comparison of ESP and GloFAS monthly inflow forecasts initialized during the May–August low-flow period at Don Pedro (DNP) for 2024 and 2025.

Section S3. SWOT-observed Water Surface Elevation and Derived Storage at Tendaho Reservoir

Figure S5 shows the time series of SWOT-observed water surface elevation (WSE) and corresponding reservoir storage at Tendaho Reservoir (TDH) from early 2024 to mid-2026. Storage was derived from SWOT WSE and surface-area observations using the estimation method described in Section 4.3 of the main text. Because reservoir storage was derived directly from SWOT WSE and surface-area observations, the WSE and storage time series exhibit closely aligned temporal variations (Figure S5). Both variables show a pronounced seasonal cycle, with reservoir filling during mid- to late 2024 and again in late 2025, followed by gradual drawdown during the subsequent dry periods. The highest observed WSE and storage occurred in late 2024, whereas lower reservoir levels were observed in mid-2025 and again toward mid-2026. These observations characterize the seasonal storage states of TDH and provide the reservoir initial conditions used in the subsequent storage forecasting experiments in data-limited regions.

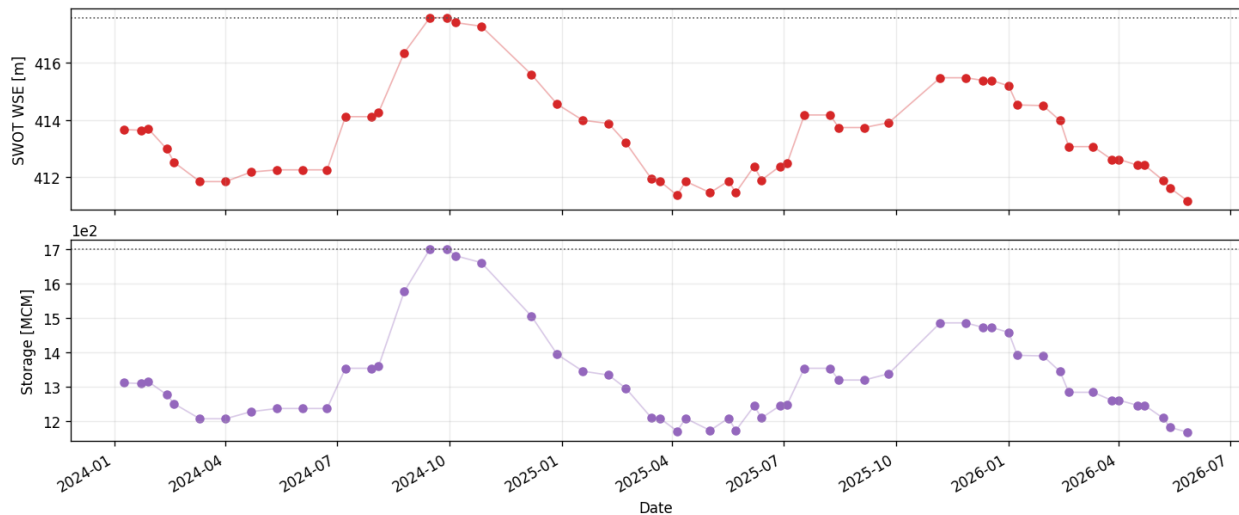


Figure S5. Time series of SWOT-observed water surface elevation and derived storage at Tendaho Reservoir (TDH), Ethiopia.

